



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

Antique Glass

by GUSTAVUS A. EISEN

GENERALITIES

ANTIQUE glass comprises vessels, beads, tiles, amulets, and other objects made of glass, inlaid with glass or otherwise decorated with glass. We may also include *glaze*, because the difference between glaze and glass relates principally to the manner in which it was employed. Glaze, paste, terracotta, porcelain, and similar substances were pliant when cold and moist. Glass, on the contrary, was made plastic by heat and fused by heat. Heat applied to paste made this substance hard. The term "paste" should on that account never be applied to glass and even the composite word *glass-paste* or *paste-glass* leads to confusion.

All objects made of antique glass deserve equal attention, careful study and scientific treatment. It is generally held that antique glass possesses only an artistic value, and in this sense it is exhibited in our museums and private collections. Although the decorative value of antique glass is very great, still we must now concede that such glass possesses other important qualities which make it an indispensable adjunct to historical, archaeological, and religious researches and which justify the most extensive collections.

The *artistic character* of antique glass relates to form, color, and technique, none of which have been equaled in modern times, but which could with profit be studied by our modern artists before they attempt to invent forms of their own. The colors of antique glass are softer and more harmonious than those now employed and thus they have inspired more than one prominent artist, decorator, and designer.

The *archaeological importance* is only now being fully understood. Both the form and color of antique glass underwent continual change, sometimes from year

to year, sometimes from generation to generation. Neither forms nor colors were repeated except at long intervals of time and then never with such an exactness that we may not readily separate the repetitions from the originals. On this account we now recognize that glass and glass beads furnish a more accurate means of dating the objects with which they were excavated than do coins, which were often hoarded up during generations.

The *historical and geographical value* of our glass depends upon the centralization of its manufacture in ancient times. Most of the ancient glass must have been made in Egypt, and only a limited quantity in Syria, Italy, Spain, and Gaul. From these centers the glass was distributed along trade routes, thus indicating the intercourse between different nations, and the manner in which they were dependent upon each other. With the glass and other merchandise went new ideas and improved manners and morals. The influence of beauty was often more lasting than that of the sword. The importance of glass in this respect is not confined to the Old World, but extends also to our American continents. Glass, as we all know, has been found in native tombs from Cape Horn to the Arctic and many efforts have been made to explain its provenance. It has even been suggested that the glass beads were brought here by the Norsemen, while others have held that the beads were manufactured here from "imported material." In order correctly to interpret the known facts, an intimate and correct knowledge of antique, mediaeval, and modern glass is necessary. It is far from illusory to assert that, if an intercourse between this country and the Old World existed in ancient times, this intercourse might best be verified by a study of the beads found in tombs. It has been stated that this assertion is greatly discounted by the presumed fact that the Venetians imitated the antique beads and that such imitations are undeterminable. This theory is wrong, however, from beginning to end, because the Venetians never knowingly imitated any antique beads. They had no knowledge

of such beads nor of the technique by which they were made. The earlier antique beads differ from the later ones to such an extent that they may be readily recognized, and only in case of plain, uncolored, spherical beads is there any difficulty of identification.

The *anthropological importance* of antique glass is highly interesting. As an example, it may be stated that beads of glass, fig-shaped, first appear in the tombs of the 9th to 8th century B. C., and thus corroborate the already established theory that the fig tree was introduced into the Mediterranean basin about that time. In this manner we find the date of an important economical event, confirmed by archaeological investigations. Similarly, the introduction of an especially large quantity of dates from Egypt into distant countries was accompanied by vessels of glass imitating the fruit and its coloring. In tombs of the fifth century B. C. in Syria, Egypt, and Carthage we find elaborate and sometimes very beautiful beads of glass representing Assyrians, Persians, Syrians, Greeks, Scythians, Gauls, Nubians, and other as yet unidentified races, probably those with which the Egyptians at that time came in contact. If we remember that this was the period of the Persian invasion, these finds become highly interesting and even important. We also find in the same tombs heads of sheep, goats, and other animals, probably such as were made known to the Egyptians by invading tribes. It has been possible to separate nearly forty distinct types of such heads so sufficiently well characterized and technically perfect as to be recognized with considerable certainty.

The *religious nature* of antique glass has not hitherto been insisted upon, so far as I know. Still, we must recognize its importance, because many glass vessels or representations on glass were intended to illustrate objects sacred to pagan, Christian, and Jew. In pagan glass we recognize vessels and other objects sacred to Bacchic rites. Among the Jewish religious objects we find the candlestick and the vessels of the Temple, perhaps even the "garden of delight" which

consisted of a decorative vine of gold with leaves and clusters. Among the Christian religious objects I have recognized chalices, mystic vases, the vessels of Joseph of Arimathaea, and various other legendary, traditional, and mystic objects reflecting upon the Passion of Christ, and upon the rites and traditions of the early Church. When compared with various representations on the walls of the catacombs, upon sarcophagi, stelae, and epitaphs, these objects receive an importance not hitherto suspected. They furnish us with material of which, so far, no one has made any special use.

The *educational value* of antique glass consists in its beauty of form and color, in the objects imitated or represented, which when explained to the undeveloped mind must stimulate it as does a fairy tale. The wonderful iridescence of antique glass, the marvelous harmony of even a fragment of mosaic glass, needs no explanation to be appreciated, and such specimens in the home or in the school would illuminate and gladden the heart. They would constitute a center of attraction and wonder to old and young. Art should be taught before morals, because art tends to improve morals, but morals do not necessarily create art. If the art of nations were taught instead of the wars of nations, the object of teaching and education would be more easily attained. The art of nations makes all nations akin, but the history of wars of nations has principally had the effect of creating enemies; art should be taught before anything else. In the writer's opinion no objects are better suited for that purpose than antique glass.

ARTISTIC, HISTORICAL, AND ARCHAEOLOGICAL PERIODS

Period of Glaze

The origin of glass is uncertain, but it seems probable that it developed from glaze. Glaze was already in use in Egypt about one thousand years before the first dynasty, the earliest objects covered with glaze being made of pottery and stone. The earliest glaze was pale green in color and of sufficient durability to have lasted to the present day. During the period of glaze,

great advance was made in technique, and in the 12th dynasty we find glaze which is both durable and beautiful. From that dynasty I have seen beads which, though made of paste and glazed, were almost as translucent as glass. Two Horus eyes dated from that dynasty, one in the University Museum in London, and the other in a New York collection seem actually to be of glass. But the date of these two objects is not indisputable and as no glass vessels have been found before the 18th dynasty we are forced to assume that it was not until that time that glass became generally known, even if it had been invented long before.

A study of glaze is of great importance, not only from a purely artistic point of view, but because it changed from time to time, sometimes improving, sometimes degenerating in quality, color, hardness and gloss. The glaze thus furnishes us with means of dating and identifying many objects, not otherwise determinable. During the 12th dynasty the glaze was almost imperishable, and beautiful in color. In the 8th and 9th centuries the glaze had degenerated to such an extent that its color is now hardly recognizable.

Period of Core-spun Glass

This name is suggested for the period during which vessels were produced by winding threads of plastic glass around a core of soft clay. The threads were later fused together, pressed and smoothed out, and finally the core was scraped out, thus setting free the interior cavity. In this manner all the earliest Egyptian glass vessels were produced, and continued to be produced until the time of the Ptolemies, when the technique of tube-blown glass was invented. All the earliest glass was opaque and milky owing to numerous bubbles in the matrix, which, far from detracting from its appearance, added softness and harmony to the colors. The period began with the invention of glass in the 18th dynasty, and lasted over one thousand years. In the course of this period various improvements and discoveries were made which led to the production of vessels and beads of glass of unsurpassed beauty of

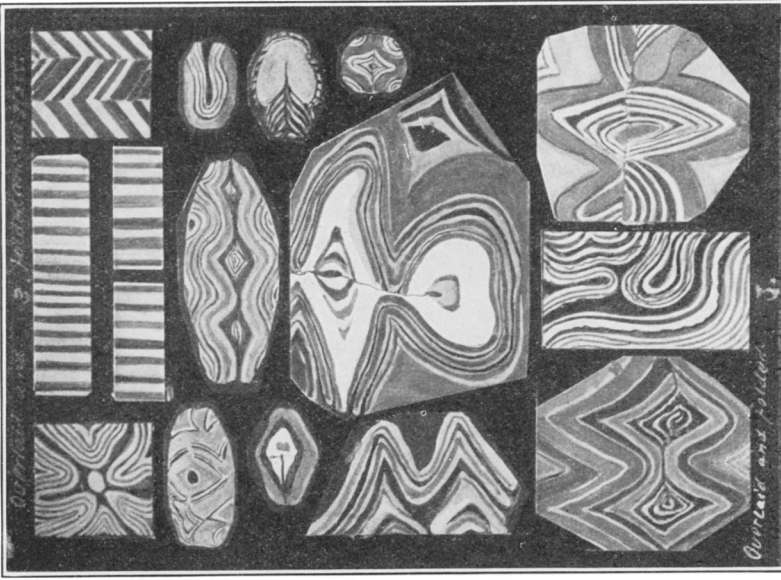
coloring. Pure white, transparent glass began to appear in the 9th to 8th century, but remained scarce for a long time and could only be employed for beads. The decoration of the surface consisted of "dragged" patterns of glass threads, rods, and bands. At first the eye-spots were plain without rings, but already during the 19th dynasty eye-spots with concentric rings became common. All such eye-spots were made by superposing successive drops of glass, and by rolling these out to a flat surface. The lower layers would thus project and appear as rings.

The "dragged" mosaic patterns must have originated from the use of glass threads in forming the glass vessel. An accidental disturbance of the threads may at once have shown that by moving them intentionally desirable patterns could be produced. The colors of this period are soft yellow, blue, brown, green, and dull violet. The intense red was not in use. During this period glass-workers imitated onyx, agate, carnelian, and various precious stones and marbles, but did not reproduce the forms of crystals. The beads were usually made in the same manner as the vessels, by winding a thread of glass around a wire, or by pushing a rod through a lump of plastic glass. Stripes of various colors were made by connecting parallel rods, which were diminished by being fused and drawn, and later ground off so as to become flat. Miniature work of this kind has been found in the Palace of Amenhotep at Thebes. At a later period the same effect was produced by grinding off a single, dipped or composite rod.

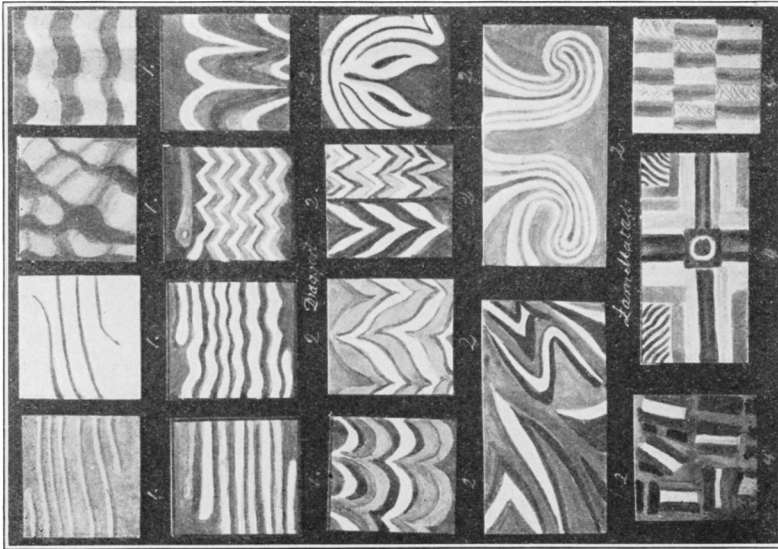
The end of this period falls in the time of the Ptolemies and may conveniently be considered to coincide with the date of the death of Alexander.

Period of Tube-blown Glass

In the time of the Ptolemies the city of Alexandria became the principal center of glass-making. Encouraged by art-loving monarchs, epoch-making discoveries and improvements were made which brought the art to the highest degree of perfection, if beauty alone is considered. These improvements revolution-



G. A. Eisen, del.



G. A. Eisen, del.
SURFACE MOSAIC GLASS.

ized the art and inaugurated a new period. Tube-blown glass vessels, stratified glass, dipped rods, and moulded glass flasks were invented. The process involved in each of these will require attention to make clear their nature and importance. The earliest attempt to blow glass was made by first producing a tube of glass, closing one end, then enlarging the closed end by blowing into the open end. The stratified glass process consisted in placing layers of differently colored glass one upon the other, and after fusing the layers, cutting off the mass transversely in strips. Of these trips tubes were made, and the tubes blown into small, delicate flasks. The third epoch-making discovery was that spots surrounded by concentric rings could be quickly and cheaply produced by simply coating a rod with different concentric layers. Small disks cut off from this rod possessed about the same appearance as the former stratified eye-spots. An artisan could with the new method produce a thousand such spots where formerly he made but a dozen. Another important discovery was that glass could be moulded and prevented from adhering to the mould by coating the latter with ashes, brickdust, or some such powder.

Besides these improvements, a new kind of glass—the *gold glass*—was invented. This glass was made by inclosing layers of gold-leaf between layers of transparent glass. The layers were then fused and thus permanently preserved. This technique was but an off-shoot of the stratified glass, and we possess many flasks made of stratified glass in which one or more of the layers consists of gold glass. Such glasses began to appear in the third century and lasted to the first century B. C. The gold glass itself continued in use a thousand years longer, and was employed especially for the making of beads. This kind of glass will be discussed in more detail later on.

This whole period may be said to have lasted from the Ptolemies to the time of Pompey the Great, when columnar mosaic rod glass inaugurated a new era.

To this period, and in all probability to the stratified glass types, belong the flasks which Nero, in the

middle of the first century, bought for an enormous price, and which he exhibited together with fragments of murrina vessels in the Theater of Pompey. The vessels which Nero bought are described as "winged." The most likely explanation of this expression is that these "wings" were exceptionally thin, high fins, such as are sometimes found on flasks of stratified glass. They were not added after the bowl had been blown but were made at the same time, the mould being furnished with deep cavities into which the glass matrix penetrated. This seems certain because the stratification ascends from the body into the wings. Such glass was a lost art in Nero's time, hence the great price which he chose to pay. Several such flasks of moderate dimensions are to be found in New York collections.

Period of Columnar Mosaic Rod Glass

The difficulty of producing "variegated" glass flasks by means of stratification was enormous, and no artisan has since attempted to imitate those flasks—even during the Renaissance, when all older methods of glass-making were successfully improved upon by the Venetians. When and how the first columnar rods were invented is not known, but I assume that the manner in which this was done, was practically as follows: Some one probably noticed that when glass rods of different colors were stacked together in bunches, their assembled ends would show patterns of various colors. Thus, when a white rod, for instance, was surrounded by red rods, red rings were seen around a white core. The next step was to fuse the rods and to draw them out into smaller rods and threads. Glass threads had already been spun in the 18th dynasty, but so far no rods with colored centers or colored rings have been found to be earlier than the Ptolemies. Once the discovery of the fused rods had been made, there was but a short step left to the art of making columnar mosaic glass. Instead of merely placing a single colored rod in a mould and surrounding it with the white rods in the form of a ring, intricate patterns were now produced in this manner. Besides rods of glass, the artist made

use of plates of glass, both kinds often being combined. Thus, for instance, a thick rod of white glass was placed upright in a pottery mould, on a base of soft clay. Radiating from this core were arranged plates of white glass, like the arms or points of a star. The vacant spaces between the core and the plates were now filled in by a packing of rods of a different color, as, for instance, green. By fusing the aggregation enough to make the rods and plates form a solid body but not so much as to make them mix, and by cutting this mass into sections, a beautiful pattern of white stars in a green field was produced. By drawing out the cylinders minor rods and minor patterns resulted and these could be combined into more complicated patterns such as geometrical figures, portraits, plants, flowers, birds, fishes, and symbolic figures. In fact, with sufficient care and skill, any and every kind of pattern that could be painted by the artist's brush could also be produced by rods and plates.

Such a matrix in order to hold together had to be thick and therefore did not lend itself well to the production of flasks or even to open vessels and plates. But at about this time the art of shaping a flask or cup from a *glass bubble* had been discovered, and one of its earliest uses was the application of this new method to the production of mosaic cups from columnar rods. Just as we find that the earliest flasks made of stratified glass were heavy and thick, so we now find that the earliest cups made of columnar rods were much heavier than those made at a later date, when the process of grinding the cups to proper thinness had been perfected. The art of blowing glass from a bubble may have been derived from the technique of tube-blown glass, since the workers must have noticed that the greater the heat applied to the end of the tube, the thinner became the bottom of the flask. Still, it seems probable that the glass itself underwent an improvement and was made more readily fusible, which made it possible to produce flasks of such paper-like thinness as the Sidonian flasks of the first century A. D. We know that at first the glass was thick and difficult to blow, because

all the early mosaic glass cups are thick and heavy. In the process of production sections or fragments of mosaic glass were placed along the sides of a mould or simply on a plate, and then fixed together by means of a bubble of glass. The next step was to press the mass into a mould, and finally to thin the walls by grinding. Many specimens have been found which were left unfinished or which broke because the artist went too far in his eagerness. Many such specimens contain in their interior remains of the thick layer of the original bubble, which often is even thicker than the mosaic layer of the bowl. That this was actually the process employed in making these little cups is also verified by certain references in verse written by the Latin poets, who deplore the fact that the artisans of Egypt often continued to grind their vessels until they broke, spurred on by the hope of increasing their profits by asking a higher price for the thin-walled specimens of their craft.

The period of mosaic glass proper seems to have begun during the reign of the last of the Ptolemies and to have ended with the first Roman emperors. According to Kisa, who has had the best opportunity of studying this feature of antique glass-making, the "heavenly murrina" was not produced after the last of the Flavian emperors. With "murrina" Kisa associates, incorrectly, no doubt, the mosaic glass of this period.

Sidonian glass, which is most representative of this period, is especially worthy of mention because of its peculiar quality. The delicacy of this ware, like that of stratified glass, has never since been equalled. Whether the flasks are small or large, they are unsurpassed in refinement of form, color, and decoration. The last consists of symbols and relief figures drawn with taste and skill. Nero was the first to exhibit fine specimens of glass. In this, as in many other art activities, he was the leader of his time. Pliny, however, sneeringly remarks that Nero exhibited broken pieces of vessels, just as if they had been the remains of the body of the great Alexander! After the time of Nero a steady degeneration in taste continued during fifteen

hundred years, and it was reserved for Kircher, a priest in Rome, to found the first museum in that city. It is greatly to be regretted that the name of that first real museum—the Kircherianum in Rome—has been blotted out and its specimens scattered among various museums.

With the Sidonian glass of the first century ends the really great period of artistic glass. The culminating perfection, attained by the stratified glass of the Ptolemies, by the columnar glass of the Augustan Era, and by the Sidonian flasks, has never since been attained. The broken fragments, over which Nero shed his tears, could never be imitated. The greatness of the art of glass was lost forever! Until that time, glass vessels had been valued on account of their beauty and their technique. From that time on, indeed, up to the present day, glass vessels have been valued according to size, lightness of weight, and bizarre forms and decorations. Even now the beauty of antique glass is appreciated by very few and some of our museum exhibits are arranged according to size and general effect.

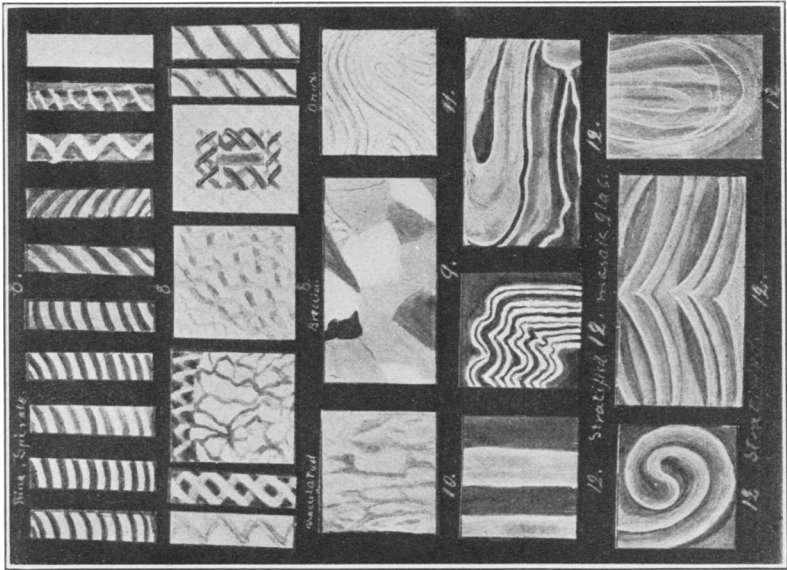
Period of Bubble-blown Glass

This period includes the time from the middle of the first century A. D. to the advent of the Arabs. Until the beginning of this period glass-making had been practiced principally in Egypt and Syria, but about the time of Pliny, who perished with the destruction of Pompeii, glass factories were established also in Italy, Gaul, and Spain. With this extension of the manufacture commenced the degeneration of the artistic and sober character of the craft. If we may judge from the statements made by Nero and Hadrian, in regard to glass, both of these art-loving monarchs preferred the older types to the new. The vessels of the whole period are characterized by an increase in size, undoubtedly due to the perfected technique of glass-blowing. Transparent white glass became common and was preferred to the colored specimens both for decorative and table use. Rare and fine specimens of both new and older types were preserved in the temples, and probably

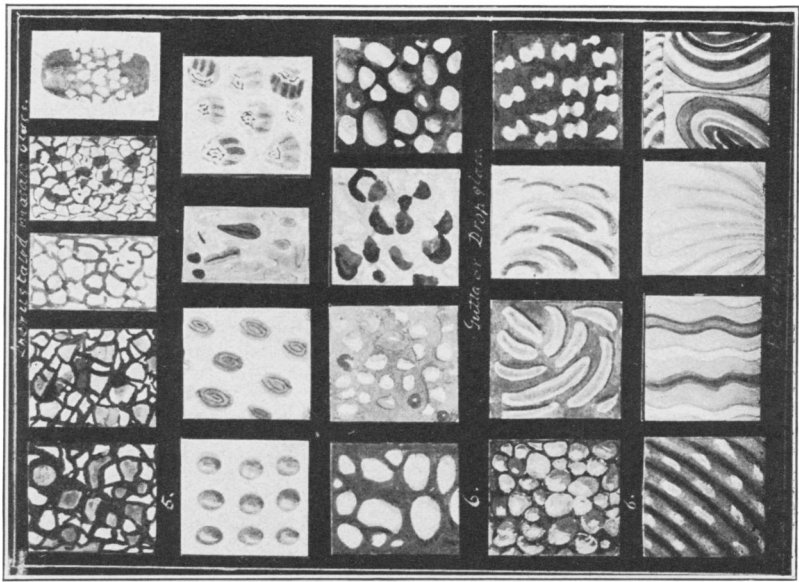
also for purely decorative purposes in households. With the increasing demand for size came extravagant decorations and forms, which continued unabated until, through war and the migration of races, communication was interrupted and the ingredients for glass-making became rare. Mosaic and stratified glass disappeared at the commencement of this period and the perfect technique of the Sidonian glass was all but lost. The best types of the glass of this period were produced in the middle of the second century; the poorest at the end of the classical period.

Kisa, in his generally admirable book on glass, divides the whole period of glass-making into ten minor periods from the time of the Ptolemies. Several of these periods are, however, now untenable, based as they are upon an imperfect dating of the typical specimens and because of the lack of recognition of the tube-blown glass. A thorough discussion of this subject is not possible in a short review, and only the mere outline of a practical subdivision according to centuries is possible. Even such divisions are, of course, not well defined, since changes in types and processes came gradually in glass-making as well as in other arts. The common characteristics of the six centuries during which the classical glass-making continued may be summarized as follows: Transparent white glass predominated over colored glass, and extravagant types over sober forms. Mosaic and stratified glass were not used in vessels, but only for beads. Technically, the types were: moulded, blown in a mould, blown from a bubble, and pressed. Reliefs and protuberances were produced in a mould, and decorations by stamps. The surface decorations consisted of glass threads, bands, rods, and drops. At first the vessels were small, but later they became larger, undoubtedly on account of a developed technique. White glass seems to have been preferred for household use. We shall now consider the minor divisions according to centuries.

First century, A. D. The forms were characterized by wide bowls, low stands, and narrow foot-disks, like



G. A. Eisen, del.



G. A. Eisen, del.
SURFACE, IMBEDDED, AND MATRIX MOSAIC GLASS.

those of the Boscoreale silver treasure and the contemporaneous Arretine (Cf. Pl. IX, fig. 12), Samian, and green-glazed pottery which undoubtedly inspired the makers. The handles, if upright, were broad and thin; if horizontal, they extended in the plane of the bowl and were even with the top. The decoration consisted of "guttae" or drops, horizontal threads, rosettes, beads, and depressed lotus petals along the base or on the lip. Sidonian glass kept its perfection to the end of the century. Beakers with cut ornaments or with drop bosses have been found in Pompeii. Diatreta vessels (See below) and cut glass began to appear and were produced with perfect technique. That some of the finest specimens of this technique known belong to the first century can be proved by the form of the vessels. The study of this period must be based primarily upon objects found in Pompeii and other cities buried in the first century. Many objects, such as beakers and flasks decorated with vines and animals and formerly ascribed to the second or even third centuries, belong to the time of Pompeii.

Second century A. D. With the reign of Hadrian a reversion to Greek forms is noticeable. Hadrian travelled continually during many years and procured and sent to Rome everything that pleased his fancy. His travels in Greece caused a revival in the taste for Greek art, and consequently Greek forms were given to glass objects. The only mosaic known to have been applied to vessels consisted of surface "guttae" or drops (Pl. XI, 6) and was generally associated with Greek forms. The new decorations, both on vessels and beads, consisted in twisted or wavy threads and rods, applied around the lip, along the handles, or down the sides of the vessels. Serpent threads were used in profusion, often in combinations far from pleasing. Reliefs were produced by means of moulds. The Church Father, Tertullian, severely criticises the use of the figure of the Good Shepherd on Christian chalices.

Third century, A. D. The use of serpent figures continued, but they were now more sober and less

complicated. Diatreta vessels of glass or of glass and silver were highly prized, but executed with a less perfect technique. The flat cups and bowls without handles which, in the first century, were wide and shallow, were now made narrower and deeper. Cut glass and cut decorations were common. Cylindrical vessels were the most fashionable, but spherical and funnel-shaped forms were also common. The necks of the flasks were either cylindrical or funnel-shaped; bell-shaped bowls were in favor. Large, multiple and elbow handles which projected far from the body of the vessels show the extravagance in taste. The decoration consisted of spirally wound and horizontally applied threads and rods of glass. Beads were decorated with "overlaid technique," the vessels were covered with "fins" and drops. Accessory handles between neck and girdle were among the curiosities of the period. The colors of the handles and threads were often different from that of the body of the vessel, which was generally a blue-green. Many flasks were decorated by depressed cavities, lines, and circles. This period is considered by many the most perfect, but, as some of the specimens upon which such a theory has been based belong to the first and second centuries, the preference must be given to these.

Fourth century, A. D. The Christian or Constantinian period. Several distinct types of vessels were produced during this century, the most characteristic being the Syrian and Jewish glass, which are characterized by being many-sided, each side furnished with a figure decoration in relief or in depressed patterns. The prevailing decoration consisted of the "wave," which is a zigzagged thread or rod, applied either on the girdle of the vessel or on the beads; but the most characteristic use of this ornament was to stretch it from the neck of the vessel to the girdle of the bowl or to its shoulder, thus leaving a hollow space underneath around the neck. Serpent threads and waves are often combined. Most of the known glass from this century comes from Syrian tombs and was undoubtedly made in that country for the use of the pilgrims to the holy places. Amulets, religious tokens, symbols, emblems

of Jewish as well as Christian nature constitute the characteristic features of this glass. Among general types we have goblets with heavy low foot-disks and tumblers without stands. These are often made with concave sides.

Fifth and Sixth centuries, A. D. Our principal knowledge of these centuries is derived from the Castel Trosino and Nocera Umbra collections in the National Museum in Rome. They show us that the types were few and simple, practical and well-balanced on wide foot-disks. The most conspicuous decorations consist of "dragged" patterns in red and white on yellowish and blue matrix as a background. Kisa considers the finest specimens to have been heirlooms from the fourth century, but such a theory is unwarranted, because the fifth and sixth century beads are characterized by such "dragged" patterns in the same colors, and it is entirely proper to assume that the vessels thus decorated were made at the time of the beads. There were many new colors in this period, such as deep orange, lemon-yellow, brick-red, opaque emerald, and olive-green, used in combinations giving a distinct character to the wares. Without a knowledge of the glass of these two centuries the glass of the Arabic period could neither be separated nor explained.

Arabic Period

When the Arabs conquered Egypt in the seventh century their first work seems to have been the robbing of tombs and the search for treasure. In these tombs they found innumerable treasures of gold, silver, and glass. The metallic objects soon reached the smelting pot, but the glass objects served in time as models for glass of their own making. It is thus possible to divide the Arabic period into two epochs. The first includes the time when antique glass was imitated. In the later epoch the Arabs were able to invent forms and decorations themselves. They at first made alabasters in the style of the ancient Egyptians, imitating the old ones so perfectly as to make them distinguish-

able only by their colors. The earliest Arabic glass seems to have been tube-blown, just like the Ptolomaic glass, the decoration consisting of "dragged" patterns like those on the old Egyptian flasks. All other types made at that time are heavy, with thick walls, small in size and poorly executed, and on this account most of these flasks have been identified by students as early Roman or Greek wares. The favorite decoration of the first epoch represented snakes, hides, and shields, objects which the Arabs valued, but which the Egyptians and Romans had scorned as unsuitable for decoration.

With the twelfth and thirteenth centuries the Arabic glass became refined and elegant in form, and the older decorations gave place to figures of animals, elegant vines, trees, flowers, and the like. From this period we possess some of the most beautiful specimens of glass ever made, decorated in enamels of blue, green, and gold. To this period belong the fifteenth century so-called Alhambra Vases, somewhat Greek in form, but with upright, flat and broad handles, never found in any other types. Besides the large vases of this kind, we possess numerous small flasks of the same general form decorated with "dragged" patterns, like the old Egyptian vases, but containing much brick-red and white. The matrix is often dull blue-black, peculiarly displeasing to an eye accustomed to the refined Egyptian work of corresponding type. Nearly all this ware has been incorrectly classified as Roman. Yet, strange to say, the Arabs to this day produce objects of glass which are carried home by tourists and which may be found in our museums variously labeled Egyptian, Etruscan, Greek, and Roman.

Of course, not all the glass in this period was made by the Arabs. Much was made by the Christians, and even the Jewish glass seems to have continued in favour. Much of the gray oxidized glass hitherto ascribed to the fourth century, probably belongs to this period.

Venetian Glass-workers

During, and partly as a result of, the Arabic conquest, the centre of the glass-making was transferred from Egypt to Venice. The Venetians soon began to fill the wants which the Arabs were incapable of supplying, and it is presumed that they had achieved a reputation long before the time of Marco Polo. The date of the earliest Venetian glass is not determined. Some have suggested the sixth or seventh centuries, but it seems improbable that this glass was made to any considerable extent before the tenth century. In the end of the thirteenth century the great traveller, Marco Polo, returned to Venice after an absence of many years. He had discerned the taste of the Orientals and suggested to his countrymen that they apply themselves to the making of beads, which could serve as a ready material for exchange.

The suggestion must have been adopted at once; some twenty years later we find the Venetians supplying the Orient with their glassware. But the real magnitude of Venetian glass industry culminated only after the discovery of America by Columbus, when it became apparent that the Natives of the New World were as readily brought to terms by a handful of glass beads as had been the Orientals before them. In late years much of the bead trade has been acquired by the Germans on account of the cheapness of their ware, and by the Bohemians because of their perfect imitation of onyx and other stones.

In the fourteenth and fifteenth centuries the Venetians became greater experts in glass-making than the Egyptians and Romans had been. These artisans produced during their best period glorious specimens, remarkable for lightness and transparency, but displeasing on account of their often very fantastic shapes, which lacked seriousness, force, stability, and pose. The Venetians acquired their technique partly through inheritance, partly through the discovery of new or improved methods. It was by these means that they obtained a reputation as great artists. But they never

succeeded in producing anything so beautiful or so perfect as antique stratified glass, antique mosaic glass, Sidonian first century flasks, or the finer specimens of "diatreta" vessels. Their finest and most perfect work is their ribbon and thread glass made of rods containing twisted bands and threads of a distinct color and pattern. None of their work, nor that of the Bohemians, possesses the charm of the antique glass, which yet remains unrivalled. It has generally been presumed that the Venetians rediscovered the way of producing columnar mosaic or millefiore glass. This, although asserted by Minutoli and by almost every successive writer, is certainly an error, because the columnar mosaic glass technique has never been lost. We possess specimens datable to every century from the time of Augustus to the present day.

Summary of Inventions Relating to Glaze and Glass

Period of Glaze

Glaze for coating objects of stone and paste.

Period of Core-spun Glass

Invention of glass about 1500 B. C.

The core-spun technique.

Dragged threads and bands, producing dragged patterns.

Stripes by means of parallel rods.

Eye-spots and rings by layers of drops.

White transparent glass.

Onyx, carnelian, and marbled glasses.

Creasing the surface by dragging and moulding.

Period of Tube-blown Glass

Stratified glass.

Gold glass.

The dipped rod.

Eye-spots made of sections of dipped rods.

Tube-blown glass.

Blowing out a tube in a mould.

Period of Columnar Mosaic Rod Glass.

The composite columnar rod.

Columnar mosaic glass by means of rods and a mould.

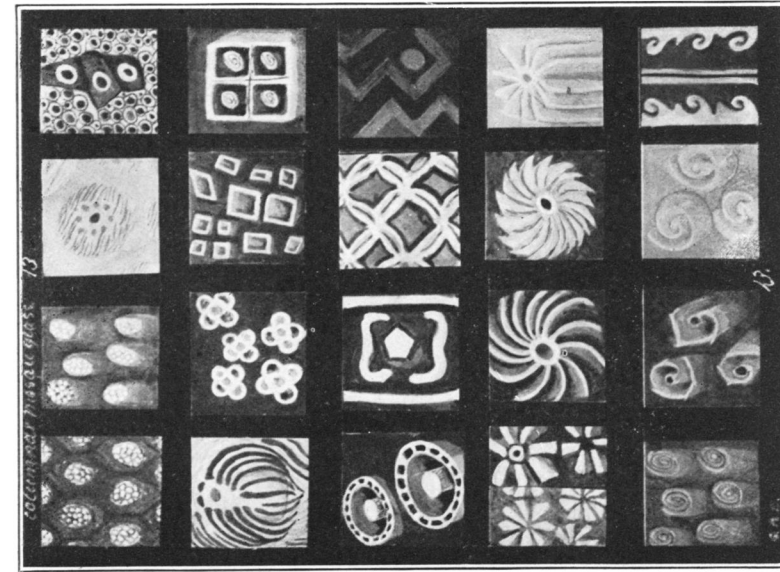
Diminishing the patterns as well as the rods by drawing.

First bubble-blown glass.

Vessels blown in a mould. Sidonian glass.

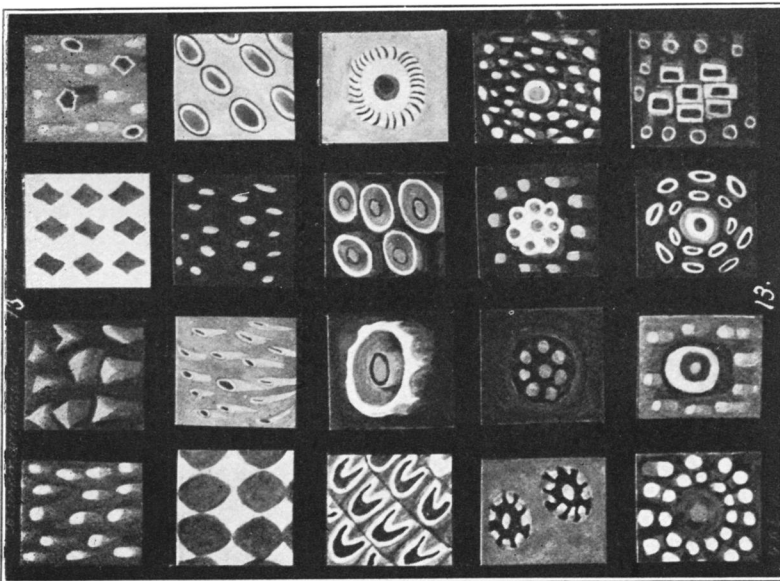
Moulding crystal forms.

Period of Bubble-blown Glass



G. A. Eisen, *del.*

COLUMNAR MOSAIC GLASS.



G. A. Eisen, *del.*

- Large vessels made by bubble-blowing.
- Moulded and cut glass in imitation of crystals.
- Cut, ground, diatreta and opus interrasilis glass.
- Pressed ornaments.
- Predominance of white transparent glass.
- Beginning, and steady continuance of degeneration of form, quality, and color. Introduction of new and bright colors.
- A continued tendency to practical and stable forms.

Arabic Period

- Imitations of antique forms.
- Imitations of antique techniques.
- Imitations of Byzantine types and technique.
- Original types.
- Introduction of new colors.
- The general use of enamels for decoration.

The Venetians

- Continuation of the antique technique, except stratified glass.
- Perfecting all types of technique.
- Star-bead glass.
- Extravagant forms.
- Disappearance of harmonious coloring.

CHARACTERIZATIONS AND DEFINITIONS

Glaze is the outer glossy layer on pottery. It is derived from a mixture of earths and other ingredients and is generally applied when cold and fluid, but hardens with heat. When oxidized it may become iridescent. It often possesses a lustre due to the use of metallic salts in its composition.

Paste, terracotta, china, pottery, majolica, porcelain, etc., are mixtures of earths and minerals ground finely and mixed with water to make them plastic. They are formed into vessels, beads, and other objects when cold and moist and in this respect differ from glass. Some pastes are also known as "slips."

Glass consists of earths and alkalies, as well as metallic oxides, which are fused and made plastic by heat. The plasticity of glass commences at about 400 C. and at about 500 C. it becomes liquid. Some kinds of opaque glasses are incorrectly termed "pastes," or "glass-pastes," such as the Sidonian "ivory glass," which is a real glass and not a paste. Before the 18th dynasty, all Egyptian beads and similar objects were made of paste, but with that dynasty, they were also made of true glass.

The *iridescence* is either intentional or due to accident. The intentional iridescence is extremely rare in antiquities. It consists of a very thin film of transparent glass laid over an opaque, black surface. The accidental iridescence is due to oxidation and deterioration, caused by burial in moist earth. Through the influence of the moisture and the air, the glass, as well as the glaze, has separated into layers which refract the light-rays in such a manner as to produce interference of colors, like those on the rainbow.

Lustre is not produced by oxidation but by intentionally added metallic salts. The technique of lustre was unknown in antiquity.

Oxidation of glass and glaze is of importance because different kinds of matrices produced distinct types of oxidation and iridescence. A study of this defoliation of the matrix often makes it possible to determine the nature of the objects, when and where made, where and how buried, and so forth. Some kinds of glass, when oxidized, produced iridescence under certain circumstances. A dry burial of glass produced dull oxidation or none at all. It never produced iridescence, except in cases of fire, as, for instance, when buildings were destroyed. The gray and dull oxidation of Arabic glass of the early period permits us to determine that much glass of this color, hitherto considered as early Christian, really belongs to the Arabic period. Pure white, transparent glass oxidized more readily than opaque glass. In order to preserve the oxidation which is often considered the most important artistic and commercial property of antique glass and glazed objects, the specimens should never be wiped with a moist cloth, but preferably with a brush like that used by photographers for their negatives.

Preserving the Glass and Enhancing its Colors. Glass with undesirable oxidation may be restored to much of its original beauty by brushing the surface with a cold solution of beeswax (not paraffin) in petroleum, turpentine, or any similar solvent which will readily evaporate. The wax soon hardens and preserves the glass from the influence of air. However, delicate and beautiful iridescent glass should not be treated in any manner nor should it be touched by anything but the very softest brush, as above described. Some varieties of glass have oxidized more characteristically than others, and one may often judge of the original color even when that color is lost.

Plain Glass. The matrix is uniform throughout, opaque, translucent, transparent, white or uncolored. The earliest glass, of the 18th dynasty, was milky and soft on account of numerous bubbles. These were gradually eliminated and in the 9th century pure white glass as brilliant as crystal begins to be common. The opaque glass is often referred to as "paste." This term is more properly applied to compositions of clay and earths which were moulded cold and softened with water. Glass was always moulded while hot and could only be softened by heat. The great heat required makes it improbable that the art of producing glass was discovered by Phoenician sailors as the result of an open fire made on the sandy beach at the mouth of a river.

Surface Threads and Bands. Any matrix, plain or complicated, could be decorated with threads, rods, and bands of glass when plastic. In the earliest types such decorations were not rolled into the surface of the glass, but were left more or less elevated. When they are deeply rolled into the matrix, the result is properly termed mosaic glass. The manner in which the threads were applied is often characteristic of a certain period, and all peculiarities of such threads should be noted.

Mosaic Glass. In mosaic glass variously colored units enter for decorative effect. Such units may consist of threads, bands, rods, drops,

and fragments of glass—or even foreign substances, such as metals, sand, etc. Sometimes these elements are imbedded near the surface, but at other times they constitute an integral part of the matrix.

Core-spun Glass. This is the earliest type of glass, invented in the 18th dynasty, but continued long after the conquest of Egypt by the Romans. The first part of the process consisted in shaping a core of clay and winding threads of variously colored glass around it. The threads were then fused by heat and rolled together. (The decoration was made up almost exclusively of “dragged” threads.) The last step in the process was to scrape out the core, which was always softer than the glass.

Tube-blown Glass. In making vessels by blowing a tube or cylinder of sheet-glass was rolled up and closed at one end; then by blowing through a pipe of metal or glass in the open end, the more distant part of the tube was enlarged. The process was invented in the third century, B. C.

Pressed in a Mould. The thick sheet of glass was pressed into a mould while plastic. Only shallow cups and flat objects were made in this way. The method was apparently invented in early Ptolemaic times.

Blown in a Mould. This process succeeded the tube-blown glass but preceded the bubble-blown glass. It consisted in blowing a bubble of glass against fragments of mosaic or other units set along the walls of a mould. It was common in the first century B. C. But the most perfect bubble-moulded glass is the Sidonian ware of the first century A. D. It is fine in quality, fine in decoration, and in every way perfect.

Bubble-blown Glass. The process was invented in the middle of the first century B. C. At first the method was crude but it attained perfection in the middle of the first century A. D., particularly in Sidon.

Stratified Glass. Sheets of glass of different colors were superposed in regular layers, fused together by heat, and when cold cut in thin strips. Of these strips tubes were made in different ways, by folding, by twisting, or winding around a core. Vessels were made of these tubes as already described. The pattern of decoration was formed by the edges of the layers. This glass was invented in the time of the Ptolemies.

Rod Glass. Rods of glass were placed side by side along the walls of a mould and fused. The invention is Egyptian in origin but was made in early Roman imperial times.

Cameo Glass. This is a kind of stratified glass but its employment was quite distinct. The glass, imitating carnelian and other hard stones, as well as the cameo-shell, consisted of two superposed layers, the upper one of which was carved into figures, the parts between the figures being scraped away in order to show the lower layer as a background.

Vasa Diatreta and Opus Interrasile. These vessels were made of two kinds of glass, just as was the glass cameo, but the outer layer has the form of a perforated decoration *à jour*; it is also known as openwork. The finest specimens date from the first century A. D. The technique of the type is disputed, but I imagine that the process

was as follows. The outer, open and perforated layer, was made in a deeply carved mould. Against this openwork was blown a bubble of different glass. When removed from the mould, and when cold, the outer layer was scraped, ground, cut, and polished, short pieces of glass being left to connect the two layers. It is one of the most beautiful of the antique techniques.

Enameled Glass. This was known to the Romans, who used it not only for decoration but for making larger objects, such as busts. A bust of Caracalla (?) in the Conservatori in Rome, is said to have been made by superposing enamels. The enameled process was extensively used and preferred by the Byzantines and after them by the Arabs.

Turned Glass. Many vessels, especially those of rather flat form, show that they have been turned on a kind of potter's wheel. The process was employed in diminishing the thickness of certain millefiore and Sidonian so-called ivory-glass vessels. These, as has been mentioned, were produced by blowing or pressing a thick bubble of glass against rods and plate units in a mould. This bubble as well as the superfluous thickness of the rod glass was afterwards ground off. Many such vessels show the rings caused by turning. I do not think any glass vessels were formed entirely by turning; the same effect could have been produced by first moulding the vessels and then finishing them by turning.

Handles. The technique and form as well as relative size of the handles are of great importance, because they varied with the period. Thus, in the earliest Egyptian alabastrons the handle consisted merely of a knob. In Greek times the knob was changed to a tiny handle. At a later period the handle was made larger. The quality of the surface of the handles is of importance in dating, because the handles with a smooth surface are much earlier than those strongly striated. The handles of the late Arabic alabastrons (seventh and eighth centuries A. D.) were striated or even ribbed. The handles in the time of Augustus were made wide and thin, like strips of paper. In the third and fourth centuries A. D. the handles were often zigzagged, like the teeth of a cog-wheel.

Lip. This varies considerably in type, from narrow to broad, from flat to funnel-shaped, from even in outline to pinched and trifoliate, from horizontal to upright or sloping downwards.

Surface. On the flasks as well as on the beads the surface was either naturally smooth or was made smooth by grinding. It was sometimes ground or "cut" into forms of decoration, and it was fluted or ribbed, either by creasing or by adding ribs, waves, shields, spiral threads, drops, bosses, etc.

TECHNICAL PROCESSES CONNECTED WITH BEAD-MAKING

Beads which look alike to the unpracticed eye differ materially in method of manufacture. Since the processes varied and were improved from time to time, and new and more practical inventions made, a knowledge of them becomes a necessity in classifying the objects. The technical processes concern the formation of the bead, the for-

mation of the bore, the decoration of the bead, and its finishing. By studying this subject with attention to details, it is nearly always possible to determine the date of the bead, and in some instances its provenance. A few illustrations make these facts comprehensible, as, for example, the capped beads of the 18th dynasty and the capped beads of the 2d century, A. D., which differ essentially in the manner in which they were made. The former consist of a solid unit of glass, the latter of a flat piece of rolled glass, thus producing a suture which is always recognizable.

The spherical and other beads of the time of Amenhotep which were decorated with a spiral thread, may be recognized by the manner in which this thread was commenced and by the way it was applied to the surface. Some beads, before the time of Augustus, were made, preferably, by laying a glass thread over a wire. Such beads show a short nib or projection at each end. In some beads the bore is wider at one end than at the other, the rod used having been wider at one end. The creases in melon-shaped beads were either made by hand or by rolling over a grate. By the latter method the creases often overlap at the commencement and at the end. In producing the wave, the thread was either run along in a wavy fashion without a break, or halted at the points to form a small loop or a thick dot.

Some eye-spots were made of superposed drops of glass, others were made by separate rings of glass, others again from slices of a rod with inner concentric layers.

How very little attention has been paid to these details even by those who have written upon the subject is shown by the fact that glass vessels and glass beads are often dismissed with the single word "variegated," which conveys no other meaning than that the objects were parti-colored. It is perfectly evident that no scientific value can be attached to such descriptions, which is all the more regrettable, since many of these specimens are now either lost or inaccessible.

Technique of the Matrix

Spiral Rod. A thread, band, or rod was spirally wound over a metal stylus, wire, or rod. The beads produced in this way show the ends of the thread projecting at each bore.

Perforated Unit. A small lump of glass was taken up and formed against a marble plate and finally a rod was passed through to form the bore.

Cut-off Cylinder. A perforated cylinder was first produced, then cut in slices either while soft or when hard. The ends were rounded or left square and flat.

Punched Out. The bead was punched out from a flat sheet of glass while it was soft.

Rolled-up Sheet. A small sheet of glass was rolled up longitudinally, the junction of the two edges showing as a suture.

Bent and Twisted Strip. A strip of glass, generally cut from a sheet already ornamented, was bent, or bent and twisted. In the former case but one suture was made; in the latter a suture for each bend and edge.

Parallel Rods. Four rods of glass of equal size were placed side by side longitudinally in a square, so that the sides joined. After fusing, the rods were cut in lengths and ground off to form cylinders and spheres. The inner rings of the dipped rods then showed on the surface as decorative lines.

Fused Rods. A solid rod was cut in lengths and formed into cylindrical or rounded beads. The bore was made transversely to the rod in order to show the core of the rod at the opposite ends intact.

Moulded. The bead was cast in a mould. The joints of the mould show.

The Bore and the Cavity

The bore in a glass vessel or in a glass bead offers characteristics which help to date the object. The following ones are the most important.

Scraping out the Core. The core in the core-wound flasks made of clay, was scraped away when the flask was ready.

Bore made by Punching. This was used in Egyptian disk-beads of paste and glass. A rod was used in forming the bore of the glass beads or of the hollow flasks by forcing it through a lump of soft glass. Such bores are often wider at one end than at the other, as presumably the rod was thicker at the base.

Laying over a Wire. The bore was formed by rolling or laying a glass thread over a wire or rod. Such beads or vessels show a spiral twist. Thus were formed many beads from the Egyptian New Empire to the time of the Ptolemies. The bore of many stratified glass flasks was also made in the same manner, which can be readily recognized by observing the spiral course of the thread or strip.

By a cylinder. The core of beads and of flasks was also made by first constructing a cylinder. If the opening was desired wider than the bore of the cylinder, it was enlarged by blowing out the cylinder, after one end had been closed. If it was desired narrower, the cylinder was drawn. The bore diminished with the cylinder without closing up.

By Folding. A piece of sheet glass was rolled or folded so that the ends met. All such bores or tubes show a trace of the suture where the edges meet. In beads such sutures were generally widened in time by the thread on which the bead was strung. This fact constitutes a ready means of separating the capped beads of the 18th dynasty from those of the 2d century A. D.

By Blowing a Bubble. The bubble-blown glass seems to have been invented in the first century B. C. but many of the vessels hitherto believed to have been produced that way, can be shown to have been tube-blown—for instance, all vessels made of stratified glass, all long narrow vessels with heavy walls, nearly all flasks termed by dealers "candlesticks," and many other specimens of the first century B. C., as well as of the early Arabic period.

By Drilling. The cavities and bores made in hard stone were produced by drilling with a metal instrument and corundum and emery powder. The antique drill bores are characterized by having been

drilled from two opposite sides, the two bores rarely meeting exactly. Many glass objects are also drilled in the same manner.

Technique of the Decoration

Wave. The wave consists of a zigzag thread carried along a surface. It was made either by running the thread up and down and forward without a break, or else the artist halted the thread at the top of the crests and at the base of the hollows, twisting the thread backward at the same time, thus forming a loop or a thickened dot. The former process produced round waves; the latter, pointed waves. The waves could also be produced by "dragging" in one or two directions. Another way to produce the wave was to use flat plates of glass in the manner of columnar mosaic glass, like the star-bead glass, or by rolling the surface over a grating, and then dipping the object in fused glass of a different color.

Granulation. The spots and granules of the surface were made with fragments of glass, with cut-off mosaic disks, or with drops.

Creasing by hand. Beads with parallel creases, like melon beads, show elevated ribs from pole to pole. The creases were made by pressing the bead with the edge of a tool.

Creasing by rolling. The soft and rounded bead was rolled over a creased surface with parallel ridges. These creases did not reach the poles of the bead, and often overlapped along the ridges.

Creasing by drawing or raking. Creases separated by wide ridges were made by drawing the surface with a hard sharp point of metal. This method was generally used in producing dragged patterns.

Creasing in a mould. The creases were produced in a creased mould. The two or more joints of the mould show.

Creasing cylinders. The whole cylinder was first creased and then cut in slices. Such beads show the creases up to the flat bore-ends, sometimes, even if the ends have been rounded off.

Pitting. Impressions were made in the bead by a hard point of metal. Creased ridges were sometimes pitted.

Knobs. Knobs of glass were often added to the surface, especially in the fifth and fourth centuries B. C. After an intermission the fashion was revived in the 5th to 8th centuries A. D.

Eye-spots. The technique of the eye-spots is of the greatest importance in the study of antique glass, as it assists in dating such glass with accuracy. The following methods were in use.

Impressed Rings. A small ring of glass was pressed into the surface of the glass. The Venetians sometimes used twisted threads of glass in the rings. Drops of glass were rolled into the surface of a vessel or bead and on the disk thus procured a smaller drop was placed and rolled in. The first drop then appeared as a ring, the second drop as a central disk.

Cut-off Rod. The eye was produced by cutting sections of a rod made of concentric layers. The latter formed the rings.

The impressed rings date from the first efforts of the Phoenicians to make glass objects. The stratified eyes date from the 19th dynasty, before which time the eye-spots were simple and made from a drop of

glass rolled into the surface. The cut-off rods came into use during Ptolemaic times.

These methods not only permit us to date a bead or a glass vessel, but often enable us to detect intrusions.

INTRUSIONS

Intrusions are objects which appear in connection with objects of a different date, either in the tomb, in the excavation, or in the collection: as, for instance, modern beads in an antique necklace. Such intrusions are common, and so far I have never discovered a single collection of antique glass—vessels or beads—which did not possess one or many such intrusions. The intrusions are of two kinds, old and recent.

Old Intrusions. These consist of older objects intruded among modern ones. For example, in old tombs or excavations we discover objects more ancient than the tomb. These objects were either heirlooms or derived from old tomb-robberies. They were the property of the deceased or his friends. Several necklaces of glass beads in the Castel Trosino and Nocera Umbra collections in the National Museum of Rome, contain one or more older beads. Some of these belong to the fifth century B. C.; others are from the time of Augustus. Some, again, date from but one or two hundred years before the tomb. However, the glass vessels found in these tombs, which Kisa considers as heirlooms of the fourth century, are of the same date as the tombs which belong to the sixth century A. D.

Recent Intrusions. These consist of objects of later date, generally modern specimens, which have been, purposely, by accident, or by ignorance, coupled with the more ancient objects. I have noted numerous such intrusions. For instance, a necklace of Modern Arabic beads in the Vatican Museum is labeled "Pharaonic, 18th dynasty." A vase of Venetian star-bead glass in the same Museum is labeled "Roman mosaic glass." A necklace of modern Venetian beads is shown in a collection of objects labeled, "First iron age," in the Museum of Berne. A Venetian necklace of oblong beads with "dragged" decoration, is exhibited in the University of Perugia Museum as "found in a Greek vase of the third century B. C." A modern Venetian necklace is exhibited in the Antiquarium of Munich in a case with Egyptian dynastic beads, and in the same collection a necklace of modern Sudanese beads is said to have come from a dynastic tomb. In the Etruscan Museum of Rome, in Villa Giulia, two central beads in a fifth century B. C. necklace are modern, one possessing an eye made of a twisted thread ring. In looking up the record of the necklace, Dr. Giglioli found that, contrary to supposition, the necklace had been purchased and not excavated. Finally, I must call attention to the fact that star-beads, all of which are Venetian, are common in necklaces that come to us from Egypt, Syria, and even Italy. The star-beads seem to have been the most appreciated type of beads of the Venetian factories of the fourteenth and fifteenth centuries. Such beads come principally from Arabic tombs.

SPECIAL REFERENCES

Gold Glass and Gold Glass Cups

Gold glass contains a thin gold leaf between two layers of transparent white glass. The effect produced by such glass is superior to that of solid gold. The glass sparkles, but is at the same time soft, and does not refract the rays of light in the same glaring manner as does a surface of gold. This is especially apparent in gold glass beads, the edges of which are soft and subdued, while the edges of pure gold beads are sharply defined and harsh. The glass was probably prepared in two different ways, according to the use for which it was intended. If intended for vessels, the gold leaf was spread over a flat surface of glass and made to adhere to it by some thin adhesive matter like gum, albumen, honey, etc. When dry, another thin sheet of transparent glass was placed on top and the two sheets fused together. If intended for beads, the process was necessarily different and was probably as follows: A thin tube of glass was covered with gold leaf. It was then inserted into a slightly larger tube of glass, and the two tubes were then fused. Instead of gold, silver and other metal-leaf were used, and silver glass is even more common than gold glass. Such glass did not lend itself well to being drawn, or extended by blowing, as the gold leaf, which would not stretch at the same rate as the glass, would crack in every direction. Such cracks are actually seen in all specimens of gold glass vessels, but are less apparent in beads, which required to be only slightly extended and modified in form and size. A defective quality of this glass is shown by the fact that it was apt to separate into its component parts. Beads, especially, suffered in this manner, and many specimens show large chips at the ends, exposing the middle layer of gold. To prevent this tendency a small cap of plain glass was generally placed at each end of the bead. This cap closed the opening between the two glass layers and held them together. Gold glass seems to have been invented in the time of the Ptolemies, the earliest specimens dating from the third century B. C. It continued in use during the empire, but its quality degenerated from the time of Augustus, and the mediaeval objects which have been preserved give no idea of the beauty of the older ones. It was used both for vessels and for beads. The most glaring defect in the late empire glass was that the layers separated from the gold and heavy and unsightly caps had to be placed on the beads in order to prevent them from falling into fragments.

The fame of the gold glass is due partly to its use in mosaic glass from the third century B. C. to the second century A. D.

Greater interest is now attached to the cups made of this glass which have been found in the catacombs. The interest is due to the gold glass graffiti in the bottoms of the cups. These figures were produced by scratching the gold leaf with a needle, thus forming non-metallic lines in the gold surface. Some of the scenes are pagan, but the majority are decidedly Christian, representing Christ, apostles, and saints. Some scenes are, however, strictly Jewish, showing the

ark, the seven-branched candlestick, palms, Jewish vessels and other objects from the Temple. One of the most interesting depicts a Greek temple, in the tympanum of which is a seven-armed candlestick. An inscription confirms the supposition that this was intended to represent the Great Temple of Herod, which possessed a Greek form. But it cannot be assumed that this illustration was based upon anything except tradition, and it adds but little, if any, to our knowledge of the appearance of the Temple, although it confirms the idea that the central structure was Greek in style. Generally, only the bottoms of the cups remain, as they are the only parts which contained graffiti. Most of them were found in the cement which sealed the "loculi" or tombs of the Christians, and theories have been advanced to explain why they were placed there and why they were always broken. I venture to suggest that the scenes of Christ and saints were regarded as protective amulets to the defunct, and that the cups were placed in the cement in such a manner as to be readily seen from the passages in the catacombs. They indicated to the living that the deceased was a Christian, and served as a warning to the evil spirits and influences, which were supposed to haunt these dark places, that the dead should not be disturbed because he rested in Christ. The saints represented were probably the patron saints of the deceased, and it has been observed that when two saints were depicted in the same cup, these two saints had their celebrations on adjoining days. There are no good reasons for assuming that these cups were used as communion chalices, nor that they served as identification marks by which relatives could recognize the graves of the members of their family or those of friends.

Sacred Vessels Reproduced in Glass

Already in the first century it seems that sacred vessels were reproduced in glass, generally in diminished size. In the fourth century such vessels became common. Such sacred vessels were doubtless limited to very few types. So far, I have identified the following: the cup of the Last Supper; the vessel in which Joseph of Arimathaea collected the blood of Christ; the flasks in which Joseph of Arimathaea preserved the blood, and which he carried with him; the wine jars of the Wedding Feast at Cana; storage flasks and wine casks for the Eucharistic wine; and mystic chalices with the wine, vine, and the loaves.

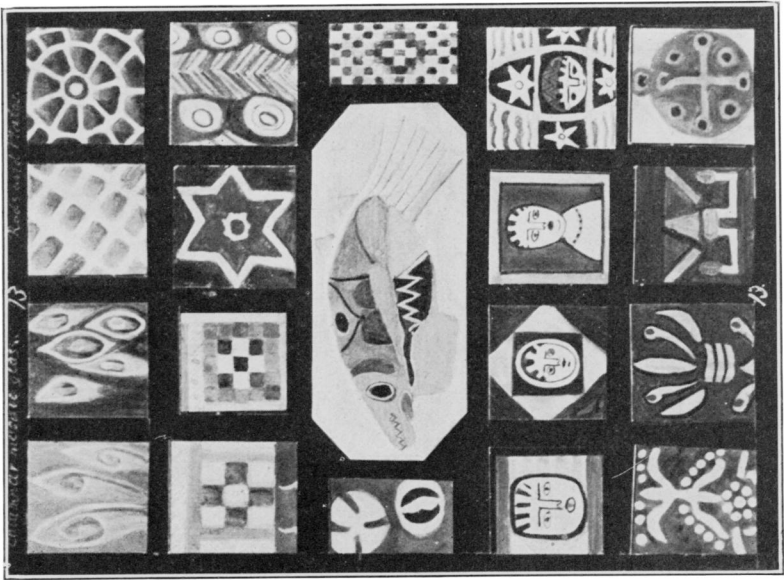
The glass amulets used by the Christians of the fourth century A. D. were numerous. These were sometimes of the same form as some sacred object, sometimes that sacred object was engraved, stamped, or otherwise added on some indifferent object. Besides Christian Jewish and pagan symbols were common.

The Units of Columnar Mosaic Glass

The primary units consist of *rods* and *plates*. These rods and plates may be used singly or in combination, and by such combinations a great, or perhaps an infinite, variety of patterns may be produced.



NEW YORK, METROPOLITAN MUSEUM: GOLD GLASS.



G. A. Eisen, del.
COLUMNAR MOSAIC GLASS.

Rods. The rods are either plain or decorated. The plain rods consist of monochrome rods of glass used singly or in combinations. They need no further description. The decorated rods were produced in various ways. *By dipping.* A plain rod was immersed in molten glass of a different color and thus actually coated. *By association.* A plain rod was placed in a mould in an upright position and surrounded by other upright rods of different colors, so placed as to produce a pattern. When these rods were fused and drawn out, a small rod as large as the original plain rod was produced, but the new rod contained in its interior the new pattern. This pattern was made visible either by cutting the rods in disks, or by grinding off the rod longitudinally. In the former process the rings were displayed or a center dot was seen surrounded by other dots, etc. By grinding off the longitudinal surface the central core appeared as a rod lined by two other rods, resembling a triple band, common in mosaic glass. *By rolling a sheet.* The decoration was also produced by rolling a sheet of glass and filling in the space with other rods. Such a rod when cut off horizontally looked like a scroll seen from the end.

Plates. Instead of rods, plates of even thickness were placed in the mould and the spaces between the plates were filled in with rods, of a distinct but uniform color. In this way star, scroll, spiral, cubist, chess-board, honeycomb, etc. patterns were produced.

Combinations of Plates and Rods. The greatest variety of designs could be produced by combining rods with plates. I instance some. *Stars.* A central rod was surrounded by plates. The latter formed the arms or points of the star, the rod was its center. *Volutes or scrolls.* By placing the plates in a circle, or a spiral, rings and scrolls were produced but these can be distinguished from rings and spirals and scrolls formed in a different way, because the plates never joined so accurately that their joints could not be recognized by an open space, a spur, a crease, or a break. Cubist heads, flowers, plants, fishes, insects, ornaments of every kind were produced in this manner, and constitute the glories of mosaic glass patterns. The star-bead glass of the Venetians was produced by such combinations of rods and plates, but in order that the star points might show on the sides of the bead, the latter had to be rounded off at the ends by grinding, or the beads were ground to faces like precious stones. The star-bead is of special interest to American students, as such beads have been found in many tombs in the Western hemisphere since the time of Columbus, all having been brought here by the Spanish or other traders.

Color References

French chemists, among them Berthelot in particular, have analyzed the colors of antique glass and published the results. From their accounts, we learn that the ancients used about the same minerals as do modern glass-makers, but they did not possess as great a variety. Unfortunately, all these researches are useless to the present investigator for various reasons. They do not describe the colors in such a way that we can understand what is meant and they are not able to tell from what locality the glass was obtained. Thus, all the work

must be done over, with material accurately dated and with control specimens deposited in some museum for future reference.

Without alluding to the chemical composition, it can be said that it is often possible to determine a bead or a vase by its color alone. A table of colors in use from the Old Empire in Egypt to the present day might be compiled, but the publication of such a table would offer innumerable difficulties which modern printers are not likely to overcome. Certain colors were scarce at certain periods and from time to time new colors were added. Thus brilliant crimson was not known until the time of the Ptolemies. In the time of the early Roman emperors the following new colors were introduced, perhaps from the distant Orient: opaque emerald green, opaque deep orange, a certain kind of opaque deep lemon. A most interesting study is in observing how the colors gradually disappeared, deteriorated or were replaced by others. Such deterioration and disappearance undoubtedly depended not alone upon taste but also upon changes in trade, in opening up new trade routes and in the closing of others. Keeping these colors in our mind, it is possible to recognize at once whether a necklace or a vessel belongs to Egyptian, Roman, or Mediaeval times.

KEY TO THE CLASSIFICATION OF ANTIQUE DECORATED AND MOSAIC GLASS

(The nomenclature and key are proposed by the author.)

A. SURFACE MOSAICS. Thread and band glass. The ornamental units are confined to the surface of the glass, or pressed into it. Principal types: Pls. X and XI, 1, 2, 3, 4, 5, 6.

Undisturbed Threads and Bands (Pl. X, 1). The units consist of threads and bands, always more or less retained in the same position as when laid on the matrix. Varieties: *a.*—Threads deeply rolled into the surface. *b.*—Threads slightly rolled in. *c.*—Bands deeply rolled in. *d.*—Surface bands. *e.*—Fused bands.

Dragged Threads and Bands (Pl. X, 2). The units consist of bands or threads which have been given a distinct character by the process of dragging. Varieties: *a.*—Waves. *b.*—Zigzags. *c.*—Arcades. *d.*—Garlands. *e.*—Foliate-plumate. *f.*—Semifoliate. *g.*—Scattered foliate. *h.*—Helicoid-foliate.

Overlaid-folded (Pl. X, 3). The units consist of bands or threads which have been disturbed by twisting, folding, or partial elimination. Varieties: *a.*—Single fold. *b.*—Single twist. *c.*—Double fold. *d.*—Double zigzag fold. *e.*—Triple fold. *f.*—Double ear. *g.*—Overlaid herring-bone. *h.*—Diamond or lozenge patterns.

Lamellated Mosaic Glass (Pl. X, 4). The units consist of thin lamellae applied to a matrix, transparent or opaque. Varieties: *a.*—Entire lamellae. *b.*—Fragmentary lamellae. *c.*—Framework patterns. *d.*—Tesselated patterns.

Incrusted Mosaic Glass (Pl. XI, 5). The units consist of fragments of glass rolled into a matrix. They are generally irregular. Varieties: *a.*—Incrusted fragments. *b.*—Incrusted rod sections. *c.*—Bead incrustations. *d.*—Volute-rods. *e.*—Star-bead incrustations.

Gutta or Drop Glass (Pl. XI, 6). The units consist of drops of glass fused onto the matrix, and more or less deeply rolled in. *Varieties*: *a.*—Scattered guttae. *b.*—Confluent guttae. *c.*—Embossed guttae. *d.*—Drawn guttae. *e.*—Hour glass guttae. *f.*—Rod drops.

B. IMBEDDED MOSAICS. The ornamental units are imbedded in a more or less transparent matrix but do not reach the surface of the glass except where this has been accidentally worn or, occasionally, purposely ground off. The units are for the most part, threads, bands, gold leaves, and crystals, and sometimes even rods, but the latter are never intended to stand on end. Principal types: Pl. XI, 7, 8.

Rod Glass (Pl. XI, 7). The matrix is made up of rods, the ornamentation resulting from the greater density of the edges of the rods or from colored rods alternating with transparent and uncolored ones. *Varieties*: *a.*—Simple rod glass. *b.*—Parallel rods. *c.*—Parallel rod-waves. *d.*—Fasciated rods. *e.*—Streamer rods. *f.*—Surface-threaded rods. *g.*—Ground-off rods.

Trina and Lace Glass (Pl. XI, 8). The matrix is made to contain rods, threads, or bands in its interior. The bands etc. are twisted into spirals etc. *Varieties*: *a.*—Single trina. *b.*—Multiple trina. *c.*—Beaded trina. *d.*—Rectangular trina. The name "trina" seems preferable to "lace glass," the latter name being also applied to an entirely different type in which the threads themselves form the matrix.

C. MATRIX MOSAICS. The matrix of the glass is made up of mosaic units which penetrate, more or less, the whole glass from one surface to the other. Generally this glass is intended to be viewed both in transparent and overhead light. Principal types: Pls. XI, XII, and XIII, 9, 10, 11, 12, 13, 14.

Agglomerated Mosaic Glass (Pl. XI, 9). The matrix is made up of fragments of various kinds of glass in the rough, fused into a mass in which the units retain their outline and color. *Variety*: *a.*—Brecchia glass.

Maculated Mosaic Glass (Pl. XI, 10). The matrix is made up of fragments or sections of bands, etc., all fused to such an extent that the original form has been more or less lost. *Varieties*: *a.*—Plain maculae. *b.*—Maculae of columnar mosaic glass.

Onyx Glass (Pl. XI, 11). The matrix is made up of layers, fragments, or rods in a manner to imitate natural stones, such as onyx, carnelian, chalcedony, agate, alabaster, murrina (fluor-spar?), marble, jasper, etc.

Stratified or Layer Mosaic Glass (Pl. XI, 12). The matrix is made up of sheets of glass standing on end, or perpendicular to the surface. The layers are always more or less parallel to each other even when bent and twisted. As the principal types have been described in *Art and Archaeology*, VI, 1917, No. 2, p. 69, they need not be rehearsed.

Columnar Mosaic Glass (Pls. XII and XIII, 13). This type is also known as millefiori glass. It is generally spoken of as mosaic glass, and dealers and museum men often commit the error of calling it "murrina glass." The columnar rod glass is so called because it is made up of masses of columnar rods, standing on end and packed

side by side in a parallel manner and fused in a mould. The cylinder is afterwards cut into thin slices, and the glass is made of these slices either by placing them over a core of common glass, or along the walls of a mould, after which a bubble of glass is blown against the slices so as to hold them together.

Gold Glass (Pl. XIII, 14). This glass contains a film of gold or other metal, enclosed between layers of transparent glass.

BIBLIOGRAPHY

(Only the more important works are included in this list.)

- Abercomby, John. *The Chronology of prehistoric glass beads and associated ceramic types in Britain. Journal of the Anthropological Institute of Great Britain and Ireland.* Vol. 35, p. 256.
- Akerman, John Younge. *Remarks on a colored drawing of some ancient beads. Archaeologia* XXXIV, 1852, p. 46.
- Angelo, Giuseppe. *II Vetro.* Milano 1902.
- Ballo, Luigi. *Delle perle vitree, etc. Atti d. R. Istituto Veneto d. Sc.* 1902-3, T. LXII.
- Bissing, F. W. von. *Sur l'histoire de verre en Egypt.* R. A. 1908, I.
- Boulanger, Cl. *Le mobilier funeraire Romain en France.* Paris 1902-5.
- Closmadeuc, Dr. G. *Les gougards. Rev. Arch.* Dec. 1865.
- Curle, James. *A Roman frontier Post. Glasgow* 1911.
- Dillon, Edw. *Glass.* 1907.
- Eisen, G. A. *The origin of glass blowing. A. J. A.* Vol. XX, no. 2, 1916.
- Eisen, G. A. *Eye-beads. A. J. A.* Vol. XX, no. 1, 1916.
- Eisen, G. A. *Button-beads. A. J. A.* Vol. XX, 1916, no. 3.
- Eisen, G. A. *Stratified glass. Art and Archaeology.* Vol. VI, Aug. 1917.
- Giacomuzzi, Giov. *Prezzi coventi.* Venezia 1854.
- La Grancière, A. *Les parures préhist.* Paris 1897.
- Hampel, Joseph. *Altertümer des früh. Mittelalters in Ungarn.* Braunschweig 1906.
- Kisa, A. *Das Glas.* Leipzig 1908. The principal and most reliable work on Antique Glass.
- Maciver, Randall, and C. Leonard Wolley. *Buhen.* Philadelphia 1911.
- Nieuwenhuis, A. W. *Kunstperlen und ihre kulturelle Bedeutung. Int. Arch. f. Ethnographie.* XVI, pl. XIX.
- Nesbit, Alex. *A descriptive catal. of glass vessels.* South Kensington 1878.
- Petrie, William M. Flinders. Many papers in the publications of the Egyptian Exploration Fund contain illustrations and references to beads.
- Reinecke, G. P. *Glasperlen vorrömische Zeiten. In Altertümer unsr. heid. Vorzeit.* Bd. V, Mainz 1911. This is the first as well as the only successful attempt at a chronology of beads (of the Hallstatt and La Tène periods).

INDEX

Generalities

Artistic Character. Archaeological Importance. Historical and

Geographical Value. Anthropological Importance. Religious Nature. Educational Value.

Artistic, Historical, and Archaeological Periods

Period of Glaze. Period of Core-spun Glass. Period of Tube-blown Glass. Period of Columnar Mosaic Rod Glass. Period of Bubble-blown Glass. Arabic Period. Venetian Glass-workers. Summary of Inventions relating to Glaze and Glass.

Characterizations and Definitions

Glaze. Paste. Glass. Iridescence. Lustre. Oxidation. Preserving the Glass and Enhancing its Colors. Plain Glass. Surface Threads and Bands. Mosaic Glass. Core-spun Glass. Tube-blown Glass. Pressed in a Mould. Blown in a Mould. Bubble-blown Glass. Stratified Glass. Rod Glass. Cameo Glass. Vasa Diatreta and Opus Interrasile. Enameled Glass. Turned Glass. Handles. Lip. Surface. *Technical Processes Connected with Bead-Making*

Technique of the Matrix. Spiral Rod. Perforated Unit. Cut-off Cylinder. Punched Out. Rolled-up Sheet. Bent and Twisted Strips. Parallel Rods. Fused Rods. Moulded. *The Bore and the Cavity.* Scraping Out the Core. Bore Made by Punching. Laying over a Wire. By a Cylinder. By Folding. By Blowing a Bubble. By Drilling. *Technique of the Decoration.* Wave. Granulation. Creasing. Pitting. Knobs. Eye-spots. Impressed Rings. Cut-off Rod.

Intrusions

Old Intrusions. Recent Intrusions.

Special References

Gold Glass and Gold Glass Cups. Sacred Vessels Reproduced in Glass. The Units of Columnar Mosaic Glass: Rods, Plates, Combinations of Plates and Rods. Color References.

Key to the Classification of Antique Decorated and Mosaic Glass

Bibliography